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## (54) Diversity antenna.

(57) A diversity antenna comprising a single antenna element in the form of a quarter wave monopole 1, together with ganged switch means S1, S2 and S3 for feeding the monopole alternately at one end or the other from a common RF feed point 3. Reference 3 can either be a signal source or receiver input circuitry. The spatial separation of the current peaks when fed from either end is almost a quarter wavelength and the antenna thus acts as a diversity antenna even though it has only a single element.

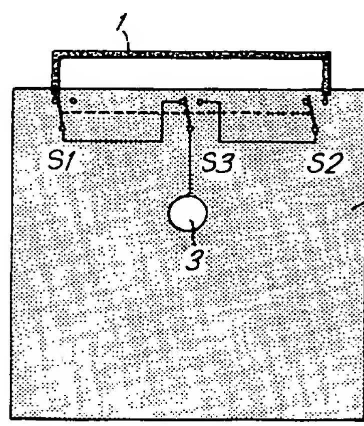


FIG. 1

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This invention relates to a diversity antenna, particularly for use in situations where space saving is paramount, for example in portable apparatus.

Diversity reception is the name given to reception by two or more spaced antennae in order to overcome propagation variations due to effects such as multipath reception and/or ionospheric variations and the like. Generally speaking some form of switching arrangement is employed to rapidly switch between the antennae so that the resultant signal at the receiver is due to the time multiplexed signals from each of the antennae in turn. Provided that the individual antenna are suitably positioned and spaced with respect to the incoming signal, the use of diversity can largely compensate for much signal path fading.

Where space is a consideration, such as in portable equipment, the diversity technique cannot usually be used because the size of the antenna system as a whole is clearly much larger than with a conventional single antenna.

In the present invention, a diversity effect is achieved with a single antenna element by driving the antenna element at two spaced locations such that the current peaks resulting therefrom are spaced apart. Thus the antenna acts, in effect, as two antennae spaced apart by the distance between the current peaks. In an embodiment, the antenna element is fed at either end alternately, diversity switching means being used to drive one end or the other. This switching can either be by way of continuous rapid switching, in the manner described above, or the switching may be carried out on an intelligent basis - i.e. only when needed due to signal conditions. The antenna can be used for reception or transmission.

In order that the invention may be better understood, an embodiment thereof will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic view of one embodiment of a diversity antenna according to the invention;

Figure 2 is a diagram of the basic printed circuit board layout of a practical embodiment;

Figure 3 is a diagram similar to Figure 2, but further showing the components necessary for switching; and

Figures 4 and 5 are views based on Figure 2, and showing diagrammatically the current distribution during right hand feed and left hand feed respectively.

Referring to Figure 1, the antenna element comprises a quarter wave strip 1 positioned above a ground plane 2 and fed from respective switches S1 and S2 at either end. The switches S1 and S2 are each connected to a changeover switch S3, and all three switches are ganged together for simultaneous operation. Reference 3 is a signal source or receiver input circuitry, according to the application. Means (not shown) are provided for driving switches S1, S2 and S3 to switch from one position to the other to provide diversity switching at the two ends of the antenna element.

In this example, the spatial separation of the current peaks when fed from either end is almost a quarter wavelength. Thus, by this means, the antenna acts as a diversity antenna comprising, in effect, two antennae spaced apart by almost a quarter wavelength. Obviously the two effective antennae thus formed cannot be used simultaneously but are configured instead, by a switching arrangement such as that illustrated, to operate alternately

Referring now to Figures 2 and 3, there is shown a practical embodiment of the invention for transmission and reception at a frequency typically around 1 GHz. Figure 2 shows the basic copper pattern of quarter wave strip 1 and ground plane 2 mounted on a dielectric substrate in the form of a printed circuit board 4. The strip 1 and the ground plane 2 are on opposite sides of the board and are thus isolated from one another: the strip 1 is on the facing side of the board, and the ground plane 2 on the reverse side of the board. In operation, the strip 1 acts as a quarter wavelength monopole.

The strip 1 is fed from either end by an identical arrangement of quarter wave transmission lines 5,6 from a common RF feed point 7. An RF feed 8 is connected via an incoming line 9 to the feed point 7 via a coupling capacitor 10. The transmission lines 5,6 take the form of copper foil strips printed or otherwise applied to the facing surface of the printed circuit board 4.

Switching of the feed from the left hand to the right hand of the strip 1 and vice versa is effected by a pair of PIN diodes 11,12. Each PIN diode is connected from the junction of a respective pair of transmission lines 5,6 to a common connection point 13. The connection point 13 is connected through the board 4 to the ground plane 2. Application of suitable DC potentials to the diodes 11,12 will enable the antenna to be switched by selectively shorting one of the feeds: the action of switch S1 is performed by the diode 11 and the left-hand quarter wave line 5; the action of switch S2 is performed by the diode 12 and the right-hand quarter wave line 5; and the action of switch S3 is performed by the action of either the diode 11 or the diode 12, and its associated left-hand or right-hand quarter wave line 6.

The diodes 11,12 are connected so that when one is forward biased, the other is reverse biased. The bias supply for the diodes is taken from a DC control input 14, via a resistor 15 and a further quarter wave transmission line 16, to the common feed point 7, and thence via the left and right-hand lines 6 to the diodes. An RF bypass capacitor 24 is connected from the junction between resistor 15 and line 16 to ground via a connection point 17 which is connected through

the board 4 to the ground plane 2.

Figures 4 and 5 show the RF current distribution during right-hand and left-hand feed respectively. Reference 18 represents the ground plane image current; reference 19 represents the current distribution in the monopole 1. Current minima are represented by reference 20, current maxima by reference 21.

The current distribution determines the radiation field of the monopole 1. The current maxima are mainly vertical so the generated radiation field is similar to that of a vertical half wave dipole centred at the active current maxima. The left and right-hand current maxima are separated by almost a quarter wavelength and thus provide spatial diversity equivalent to moving a vertical half-wave dipole by the distance between the maxima

Operation is as follows:

When a positive DC voltage is applied to the DC control input 14, the right-hand side of the monopole 1 is fed with maximum RF current 22 (Figure 4). The PIN diode 11 is biased on and shorts the junction between the left-hand transmission lines 5 and 6 to ground. PIN diode 12 is off and has no effect. The effect is to present an open circuit to the left-hand side of the monopole 1 and the common feed point 7 and thus maximise the RF current on the right-hand side of the monopole (reference 22).

When a negative DC voltage is applied to the DC control input 14, the situation reverses, and the left-hand side of the monopole 1 is fed with maximum RF current 23 (Figure 5). The PIN diode 12 is biased on, and the PIN diode 11 is off and has no effect.

The dc voltage applied to terminal 14 may either be arranged to alternate cyclically above and below ground, thus resulting in cyclic feeding of the monopole 1 from one end then the other, or may be arranged to remain at one polarity, resulting in continuous feeding from one end only, until signal conditions deteriorate to an extent which renders a changeover necessary. In the latter alternative, signal conditions can be monitored from within the remaining circuitry (not shown) to which the antenna is connected, and a control signal generated to change the polarity of the DC bias voltage applied to terminal 14 when necessary.

The DC feed quarter wavelength line 16 always presents an open circuit to RF, due to the action of the capacitor 24. The RF input 8 is blocked to the DC applied at input 14 by the capacitor 10. It will be understood that signals applied to the input 8 (RF) and input 14 (DC) are with respect to the ground plane 2.

The above-described antenna achieves diversity with just a single antenna element, thus saving space in portable equipment. The invention is considered to be particularly useful in time-division multiplex (TDM) communications systems in general; however, the particular application envisaged is as the antenna for the transceiver within a handset forming part of a cordless CT2 telephone apparatus.

## Claims

1. A diversity antenna comprising a single antenna element, and means for driving the element at two spaced locations such that the current maxima resulting therefrom are spaced apart.

2. A diversity antenna as claimed in claim 1 wherein said locations comprise the ends of the element.

3. A diversity antenna as claimed in either one of claims 1 or 2 wherein said driving means includes switch means operable to switch the feed to or from the antenna from one of said locations to the other of said locations and vice-versa.

4. A diversity antenna as claimed in claim 3 wherein said switch means comprises switching diodes

5. A diversity antenna as claimed in any one of claims 2 to 4 comprising an RF feed point at which RF signals are received from the element (on reception) or from which RF signals are sent to the element (on transmission), RF connection means for providing a separate RF connection to the respective locations on the element via respective switches comprising said switch means, and means for actuating said switches in order to alter the feed location of the element.

6. A diversity antenna as claimed in claim 5 wherein said switches are in shunt with the respective RF connection means.

7. A diversity antenna as claimed in claims 4 and 6 further comprising a dc feed point for application of a dc bias voltage to bias said switching diodes, the arrangement being such that, at any one time, one of said separate RF connections is shorted to ground, while the other is not.

8. A diversity antenna as claimed in claim 7 further including means for applying to said dc feed point a square waveform defining two different dc levels which are operable to switch said diodes in such a way as to alternate the feed locations of said element on an alternating cyclic basis.

9. A diversity antenna as claimed in claim 7 further including means for changing the dc potential applied to the dc feed point in accordance with current RF signal conditions, in order to change the feed locations of said element only when necessary according to the prevailing conditions.

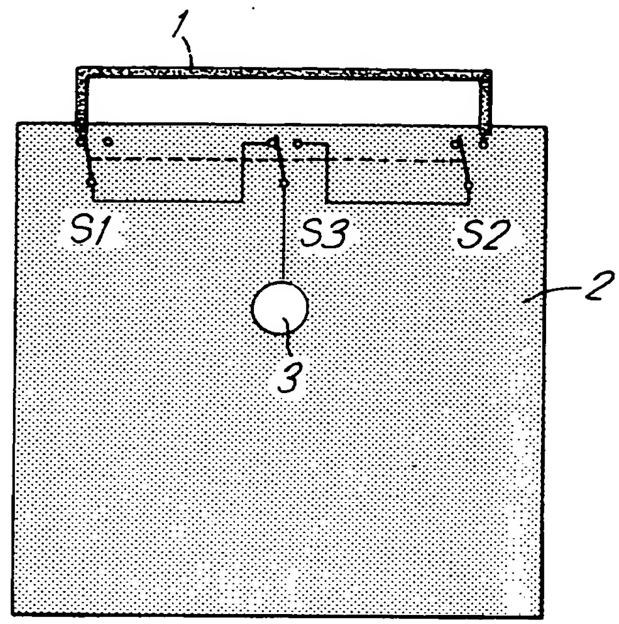


FIG. 1

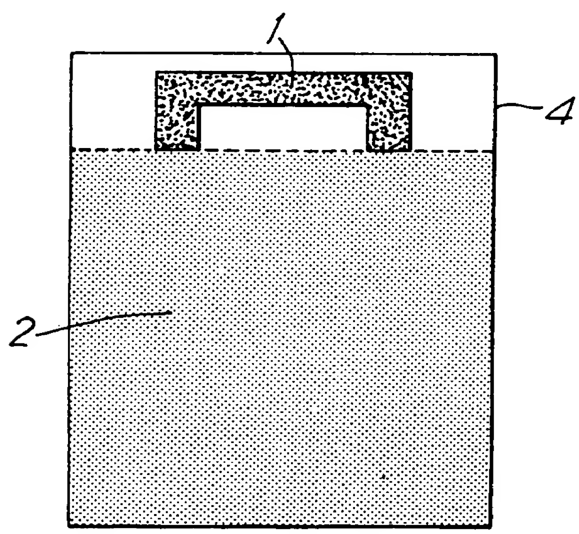


FIG. 2

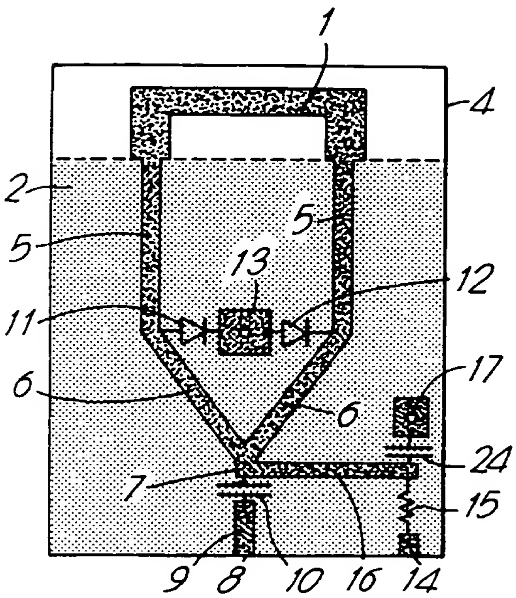


FIG.3

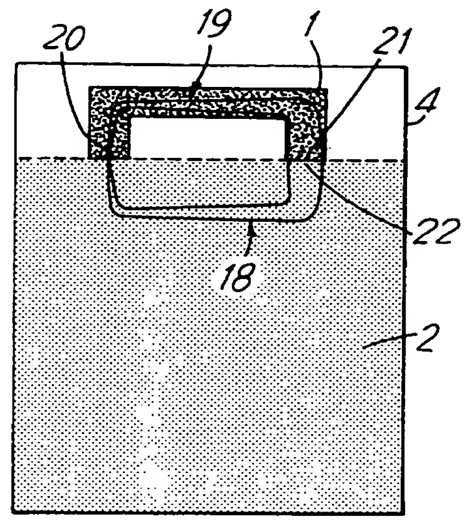


FIG.4

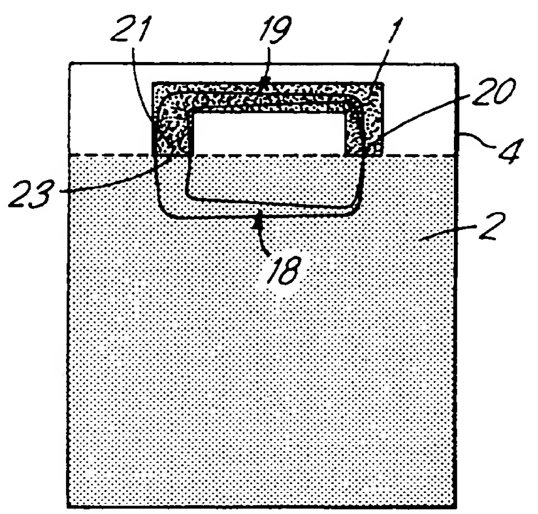


FIG.5

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# EUROPEAN SEARCH REPORT

Application Number
EP 92 31 1184

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. CL5) |
|---|---|---|---|
| X | US-A-3 818 480 (WEST)<br>* abstract *<br>* column 1, line 41 - line 65; figures 1,3,5 * | 1-6 | H01Q3/24 |
| X | GB-A-2 114 374 (THE PLESSEY COMPANY PLC)<br>* abstract; figure 1 * | 1 | |
| A | GB-A-2 088 139 (RCA)<br>* page 2, right column, line 113 - page 3, left column, line 50; figure 3 * | 1-9 | |
| A | GB-A-2 132 417 (TAIYO MUSEN)<br>* abstract; figures 1,3,6 * | 1-9 | |

TECHNICAL FIELDS SEARCHED (Int. CL5)

H01Q

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 24 MARCH 1993 | ANGRABEIT F.F.K. |

CATEGORY OF CITED DOCUMENTS

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